

UNITED STATES NAVAL ACADEMY
DIVISION OF
ENGINEERING AND WEAPONS
ANNAPOLIS, MARYLAND

19990122 097

**CALIBRATION OF
PIEZOELECTRIC ACCELEROMETERS
AND FORCE TRANSDUCERS**

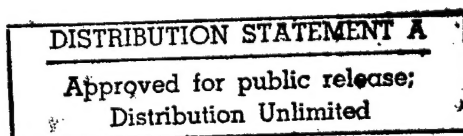
**Dr. Colin P. Ratcliffe
Mechanical Engineering Department**

EW-12-95

June 29, 1995



Dr. Colin P. Ratcliffe
Mechanical Engineering Department
United States Naval Academy
590 Holloway Road
Annapolis, MD 21402-5002
(410) 293-6535



ABSTRACT

This paper presents the calibration data for several piezoelectric accelerometers and force transducers. The work was required for NSWC and was conducted under document number N00167-95-WR-50167.

INTRODUCTION

This paper presents the calibration results for several piezoelectric accelerometers and force transducers. The work was required for NSWC and was conducted under document number N00167-95-WR-50167. Calibration accuracy is estimated at ± 0.5 dB in the frequency range noted in the tables.

Some of the transducers were new and previously unused. These are identified ^N in the tables. Old transducers have no identifying superscript.

The calibration was primarily against a 20.00 lb ± 0.01 lb steel block suspended on steel wires. A variety of excitation methods was used, including random and steady state harmonic. The tables identify which tests were used, and the frequency range in which the calibration is valid.

Initial calibration was on October 28, 1994, but values have recently been confirmed for this report.

Dr. Colin P. Ratcliffe

June 1995

CALIBRATION OF WILCOXON F4 EXCITER INBUILT IMPEDANCE HEAD

Frequency range:	750-1250 Hz
Calibration frequency:	1 kHz.
Excitation:	PRBS
Amplifier Model 456 gain for force set to:	0dB
Amplifier Model 456 gain for acceleration set to:	20dB

Enter the following V/[EU] values in HP3562A:

Force gauge	97.2 mV/N
Accelerometer	160.5 mV/[m/s ²]

CALIBRATION OF WILCOXON F4 EXCITER EXTERNAL IMPEDANCE HEAD

note that calibration was outside tolerance for this instrument

Frequency range:	750-1250 Hz
Calibration frequency:	1 kHz.
Excitation:	PRBS
Amplifier Model 456 gain for force set to:	0dB
Amplifier Model 456 gain for acceleration set to:	20dB

Enter the following V/[EU] values in HP3562A:

Force gauge	20.0 mV/N
Accelerometer	6.0 mV/[m/s ²]

CALIBRATION OF WILCOXON F10 EXCITER IMPEDANCE HEAD

Calibration frequency: 1 kHz.
Excitation: steady state
Amplifier Model 456 gain for force set to: 20dB
Amplifier Model 456 gain for acceleration set to: 40dB
Enter the following values in Solartron 1250/54:
Force gauge: 0.0099 V/N
Accelerometer: 1.26 V/[m/s²]

CALIBRATION OF PCB ICP ACCELEROMETERS

Frequency range: 750-1250 Hz
Calibration frequency: 1 kHz.
Excitation: PRBS
PCB ICP gain: ×10

Enter these V/[EU] values in HP3562A:

N309A/5136	5.772 mV/[m/s ²]
N309A/5137	5.641 mV/[m/s ²]
N309A/5138	5.987 mV/[m/s ²]
N309A/5139	5.855 mV/[m/s ²]
N305A12/11873	uncalibrated

CALIBRATION OF COUMBIA CHARGE ACCELEROMETERS

Frequency range: 750-1250 Hz

Calibration frequency: 1 kHz.

Excitation: PRBS

Charge Amplifier Type 2635 gain: $\times 100$

HP3562A V/[EU] entry: 0.1 V/[EU]

Enter the following values on the 2635 amplifier:

	(manufacturer)	(this calibration)
N3030/1000	6.51 pC/[m/s ²]	6.04 pC/[m/s ²]
N3030/1029	6.61 pC/[m/s ²]	5.89 pC/[m/s ²]
N3025/794	7.04 pC/[m/s ²]	6.51 pC/[m/s ²]
N3025/793	7.15 pC/[m/s ²]	6.59 pC/[m/s ²]

CALIBRATION OF COUMBIA CHARGE ACCELEROMETERS

Calibration frequency: 1 kHz.

Excitation: steady state

Accelerometers referenced to: Accelerometer 309A/5137

Charge Amplifier Type 2635 gain: $\times 100$

Solartron 1250/54 entry: 0.1 V/[EU]

Enter the following values on the 2635 amplifier:

	(manufacturer)	(this calibration)
N3030/1000	6.51 pC/[m/s ²]	6.28 pC/[m/s ²]
N3030/1029z	6.61 pC/[m/s ²]	6.10 pC/[m/s ²]
N3025/794	7.04 pC/[m/s ²]	6.80 pC/[m/s ²]
N3025/793	7.15 pC/[m/s ²]	7.02 pC/[m/s ²]

CALIBRATION OF FORCE TRANSDUCERS

Frequency range: 750-1250 Hz

Calibration frequency: 1 kHz.

Excitation: PRBS

Charge Amplifier Type 2635 gain: $\times 1$

HP3562A entry: 1.0 mV/[EU]

Enter the following values on the 2635 amplifier:

9071A/520137 3.99 pC/N

217A/157 2.45 pC/N

recalibrated 6/21/95

9071A/520137 4.15 pC/N

217A/157 1.84 pC/N

COMPUTER DATA FILES IN DIRECTORY C:\DTRC\PROJ_ST\CALIBRATION

These files contain the raw data used for determining calibration values. References to the "device" mean the steel fitting manufactured by NSWCC and used to put an accelerometer in-line with the exciter head.

Force gauge for F4 with inbuilt impedance head & accelerometer 309A/5137

750-1250 Hz	001Z001Z
-------------	----------

0-5 kHz	002Z002Z
---------	----------

Force gauge and accelerometer for F4 with inbuilt impedance head

750-1250 Hz	003Z003Z
-------------	----------

0-5 kHz	004Z004Z
---------	----------

Force gauge for F4 with external impedance head & Accelerometer 309A/5137

750-1250 Hz	005Z005Z
-------------	----------

0-5 kHz	006Z006Z
---------	----------

Force gauge and accelerometer for F4 with external impedance head

750-1250 Hz	007Z007Z
-------------	----------

0-5 kHz	008Z008Z
---------	----------

F10 accelerometer referenced to Accelerometer 309A/5139

30-4000 Hz	009Z009Z
------------	----------

F10 force gauge calibration (20 lb)

30-4000 Hz	010Z010Z	referenced to 309A/5139
------------	----------	-------------------------

30-4000 Hz	010Z011Z	referenced to F10 accelerometer
------------	----------	---------------------------------

calibration with "the device" on the F10 (vertical)

referenced to 3030/1029 30-4000 Hz

309A/5139 012Z012Z

F10 accelerometer 012Z013Z

referenced to 309a/5139 30-4000 Hz

F10 accelerometer 013Z013Z

3030/1029 013z014Z

Calibration with "the device" on the F10 (vertical), plus 20lb block - Columbia
accelerometer next to the F10, other two on top of 20lb block - referenced to the F10
force transducer - 30-4000 Hz

309A/5139 (top of block) 015Z015Z

F10 accelerometer 015Z016Z

3030/1029 (on F10) 015Z017Z

3025/794 (top of block) 015Z018Z

calibration with "the device" on the F10 (vertical), plus 20lb block - Columbia
accelerometer furthest from the F10, other two on top of 20lb block - referenced to the
F10 force transducer - 30-4000 Hz

309A/5139 (top of block) 019Z019Z

F10 accelerometer 019Z020Z

3030/1029 (on F10) 019Z021Z

3025/794 (top of block) 019Z022Z

PLEASE CHECK THE APPROPRIATE BLOCK BELOW:

AO # _____
☐ _____ copies are being forwarded. Indicate whether Statement A, B, C, D, E, F, or X applies.

☒ DISTRIBUTION STATEMENT A:
APPROVED FOR PUBLIC RELEASE: DISTRIBUTION IS UNLIMITED

☐ DISTRIBUTION STATEMENT B:
DISTRIBUTION AUTHORIZED TO U.S. GOVERNMENT AGENCIES ONLY; (Indicate Reason and Date). OTHER REQUESTS FOR THIS DOCUMENT SHALL BE REFERRED TO (Indicate Controlling DoD Office).

☐ DISTRIBUTION STATEMENT C:
DISTRIBUTION AUTHORIZED TO U.S. GOVERNMENT AGENCIES AND THEIR CONTRACTORS; (Indicate Reason and Date). OTHER REQUESTS FOR THIS DOCUMENT SHALL BE REFERRED TO (Indicate Controlling DoD Office).

☐ DISTRIBUTION STATEMENT D:
DISTRIBUTION AUTHORIZED TO DoD AND U.S. DoD CONTRACTORS ONLY; (Indicate Reason and Date). OTHER REQUESTS SHALL BE REFERRED TO (Indicate Controlling DoD Office).

☐ DISTRIBUTION STATEMENT E:
DISTRIBUTION AUTHORIZED TO DoD COMPONENTS ONLY; (Indicate Reason and Date). OTHER REQUESTS SHALL BE REFERRED TO (Indicate Controlling DoD Office).

☐ DISTRIBUTION STATEMENT F:
FURTHER DISSEMINATION ONLY AS DIRECTED BY (Indicate Controlling DoD Office and Date) or HIGHER DoD AUTHORITY.

☐ DISTRIBUTION STATEMENT X:
DISTRIBUTION AUTHORIZED TO U.S. GOVERNMENT AGENCIES AND PRIVATE INDIVIDUALS OR ENTERPRISES ELIGIBLE TO OBTAIN EXPORT-CONTROLLED TECHNICAL DATA IN ACCORDANCE WITH DoD DIRECTIVE 5230.25, WITHHOLDING OF UNCLASSIFIED TECHNICAL DATA FROM PUBLIC DISCLOSURE, 6 Nov 1984 (Indicate date of determination). CONTROLLING DoD OFFICE IS (Indicate Controlling DoD Office).

☐ This document was previously forwarded to DTIC on _____ (date) and the AD number is _____.

☐ In accordance with provisions of DoD instructions, the document requested is not supplied because:

☐ It will be published at a later date. (Enter approximate date, if known).

☐ Other. (Give Reason)

DoD Directive 5230.24, "Distribution Statements on Technical Documents," 18 Mar 87, contains seven distribution statements, as described briefly above. Technical Documents must be assigned distribution statements.


Authorized Signature/Date

Lawrence E. Clowers
Print or Type Name
410-293-6920
Telephone Number